PRINCIPAL MICROSPORE-TYPES IN THE PERMIAN COALS OF NEW SOUTH WALES.

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(Plate vii; three Text-figures.)

[Read 25th July, 1945.]

Introduction.

The preliminary study of microspore-types recorded in this paper was carried out as a basis for investigating microspore assemblages on various horizons in the Kamilaroi (Permian) coal measures of New South Wales. The descriptions are intended to provide a survey of general types rather than a palaeobotanical contribution, as the ultimate purpose of the work in its geological application, if characteristic assemblages are found to persist on coal-bearing horizons, is to assist stratigraphical correlation of coal seams. The types are defined in terms of a generalized classification, designed to group closely related microspores, the characterization of which will require detailed morphological studies in botanical research. It is anticipated that such work will eventually show that many of the general types described here may be subdivided into several specific types of individual character. No attempt has been made to identify the microspores with regard to the plans which produced them, as this also will require specialized botanical work.

In the case of some of the types it is difficult at this stage to differentiate between spores and pollen grains, and it is proposed to refer, tentatively, to all types as microspores for the purpose of present descriptions.

Classification based on Physical Features.

A tabular system of classification depending on physical features has been drawn up to serve as a key to the microspore-types. This system (Table 1) consists of reference squares corresponding to two sets of major features: different kinds of ornamentation and number of wings set out along the top, and shape of body and nature of tetrad scar indicated on the left-hand side. The numbered squares represent principal possibilities in type variation. The microspores are allotted type-numbers, according to the numbers of the squares to which they correspond. When several microspores corresponding to one square differ only in size or degree of development of certain features, they are distinguished by letters added to the type-numbers. For example, ellipsoidal, monolete microspores with striate ornamentation correspond to square 23, but differences in arrangement of striae (transverse and longitudinal) give two types, 23A and 23B. Microspores corresponding to some of the possible types have not been found, and such squares remain blank to provide for the inclusion of additional types, if such should be recognized. This system of tabular classification does not infer any genetical relation between different types. In the absence of exact knowledge of relations between microspores and plant species, it enables the counting of microspores and determination of assemblages in terms of general types. But, at the same time, it is recognized that variations in proportions of different types from one horizon to another must indicate proportional modification in plant assemblages, resulting from environmental or evolutionary changes.

* This investigation was undertaken when the writer held a Linnean Macleay Fellowship in Geology.

TABLE 1.

Microspore Classification based on Physical Features.

	PSILATE. (Smooth exine.)	GRANULATE. (Granular exine.)	RETICULATE. (Anastomosing ridges or grooves on exine.)	ECHINATE. (Spined.)	STRIATE. (Striated exine.)	VERRUCATE. (Warty exine.)	MONOWINGED.	BIWINGED.	TRIWINGED.
Angular tetrahedral; triangular outline. TRILETE. (Triradiate tetrad scar.)	(1) *1A.* 20–36 μ *1B.* 55–90 μ	(6) *6A.* 40–100 μ	(11)	(16) *16A.* 40–70 μ	(21) *21A.* 90–110 μ three protuberances.	(26) *26A.* 64–73 μ	(31)	(36)	(41)
Sub-angular tetrahedral; rounded apices; convex sides. TRILETE.	(2) *2A.* 36–55 μ	(7) *7A.* 50–110 μ	(12)	(17) *17A.* 30–60 μ	(22)	(27)	(32) *32A.* 50–80 μ	(37)	(42)
Ellipsoidal; oval outline. MONOLETE. (Single tetrad scar.)	(3) *3A.* 40–65 ×24–36 μ *3B.* 90–140 ×40–75 μ *3C.* 20–30 ×12–17 μ	(8) *8A.* 40–50 ×23–28 μ	(13) *13A.* 50–70 ×30–40 μ longitd. folds.	(18) *18A.* 90–110 ×45–55 μ	(23) *23A.* 50–60 ×40–50 μ trans. str. *23B.* 55–65 ×40–45 μ long. str.	(28) *28A.* 50–70 ×40–50 μ	(33) *33A.* 60–80 ×40–60 μ narrow wing. *33B.* 80–110 ×40–60 μ wide wing.	(38) *38A.* 40–80 ×30–60 μ	(43)
Spheroidal; rounded outline. TRILETE.	(4) *4A.* 20–40 μ *4B.* 75–135 μ *4C.* 40–80 μ with triangular pit.	(9) *9A.* 24–38 μ triangular area. *9B.* 50–100 μ	(14) *14A.* 40–90 μ thick walled.	(19) *19A.* 28–40 μ	(24)	(29) *29A.* 35–50 μ *29B.* 130–170 μ	(34) *34A.* 50–80 μ *34B.* 90–120 μ *34C.* 100–130 μ granulate wing	(39)	(44)
Spheroidal; rounded outline. MONOLETE.	(5) *5A.* 16–40 μ rounded opening. *5B.* 45–120 μ *5C.* 14–40 μ thick wall.	(10) *10A.* 40–60 μ closed slit. *10B.* 50–80 μ open slit.	(15) *15A.* 40–65 μ coarsely grooved.	(20) *20A.* 60–80 μ	(25)	(30) *30A.* 35–50 μ large warts.	(35) *35A.* 50–80 μ oval wing.	(40) *40A.* 25–40 μ small wings. *40B.* 35–50 μ large wings. *40C.* 50–80 μ small wings. *40D.* 35–55 μ lobe wings.	(45)

The dimensions of the microspores are given in microns, measurements being made in the optical plane in positions and along directions indicated in each case. A limited number of types is illustrated by photomicrographs in Plate vii, showing general appearance, and all types are illustrated by line drawings in Figs. 1, 2 and 3 to show detailed features. All illustrations are at standard magnification of 400 diameters, giving size comparison.*

Method of Isolating Microspores and Preparing Permanent Mounts.

The technique used in isolating microspores together with fragments of resistant plant tissue is similar to that described by Raistrick and Marshall (1939). Each coal-sample is crushed to pass a 20 mesh I.M.M. sieve, producing as little fine powder as possible, and the portion retained on a 30 mesh sieve is used for treatment. About 4 gm. is placed in a 100 ml. conical flask with 6 gm. of potassium chlorate and 60 ml. of concentrated nitric acid—the flask being immersed in water to prevent heating during the early stages of reaction. Oxidation is allowed to continue for 2 to 24 hours, depending on room temperature and hardness of coal. The residue is then washed five times with water by decantation to remove the acid solution. Owing to the granular nature of the residue, only two to three minutes are necessary for settling between each wash. The oxidized coal-substance is then dissolved by adding 50 ml. of 10% (Sp. Gr. 1.11) sodium hydroxide solution and stirring, after which water is added, and the extremely fine residue containing microspores allowed to settle for one hour before decantation. It is then washed five times, one hour being allowed for settling each time. After final decantation 2 to 3 ml. of strong alcoholic safranin is added, and the moist residue allowed to stand for half an hour. It is then stirred vigorously, allowed to settle for about 15 seconds, and the thick supernatant liquid containing microspores poured onto filter paper. The short time allowed for settling before filtering assists in obtaining an improved concentration of microspores by eliminating much of the mineral matter which sinks and remains behind in the flask.

The use of granular coal (between 20 and 30 mesh I.M.M. sieve) for oxidation as described above, eliminates fine powder which contains a large proportion of fractured microspores, fine mineral matter and powdery carbon from fusain bands. These are undesirable in the final microspore-concentrate, as they decrease the clarity of mounts for microscopic examination. Influence on proportions of microspore-types, due to removal of fine coal-powder, was tested by separate oxidation of both granular and fine materials from one coal-sample. Counts made on the final mounts showed almost identical proportions of microspore-types; but, in the case of the finely powdered portion, counting was difficult owing to large numbers of fractured microspores, and the presence of finely-divided mineral and carbonaceous matter.

In the preparation of permanent mounts about 1 ml. of strong glycerine-jelly is melted by warming, and small portions of the moist microspore-concentrate are mixed in until a drop of jelly, mounted on a slide and examined microscopically, shows the desired concentration has been reached. Three permanent mounts are then prepared from each microspore-concentrate.

Systematic Descriptions of Microspore-Types.

Type 1A. (Fig. 1. Plate vii, 1A.)

Angular tetrahedral; sharply-defined apices; flat or slightly convex sides; triangular outline. Apices of tetrahedron to opposite sides 20–36μ. Trilete; well-developed triradiate sutures extending to distal apices, and frequently opened towards proximal apex. Exine psilate.

* As a result of a suggestion by Dr. A. B. Edwards (Department of Geology, University of Melbourne), and consultation with other workers interested in microspore work on Australian coals, it is proposed that the tabular system of type-numbering adopted in this paper (Table 1) be used in subsequent work on both Permian and Mesozoic microspore-types, but that in addition the letters P, T, J or C be placed before the type numbers to signify Permian, Triassic, Jurassic or Cretaceous, respectively. For example, the Permian type 3A (described here) would become P3A, and a similar type, if found in Jurassic coal, would be J3A.

Type 1B. (Fig. 1. Plate vii, 1B.)

Angular tetrahedral; similar to Type 1A, but much larger; 55–90μ from apices to opposite sides in proximal view. Trilete; sutures frequently opened as far as the distal apices. Exine psilate.

Type 2A. (Fig. 1. Plate vii, 2A.)

Subangular tetrahedral; rounded apices; convex sides; ill-defined triangular outline. Trilete; somewhat curved lines extending towards distal apices tend to assume triradiate or crude spiral arrangement. Size 36–55μ from apices to opposite sides in proximal view. Exine psilate.

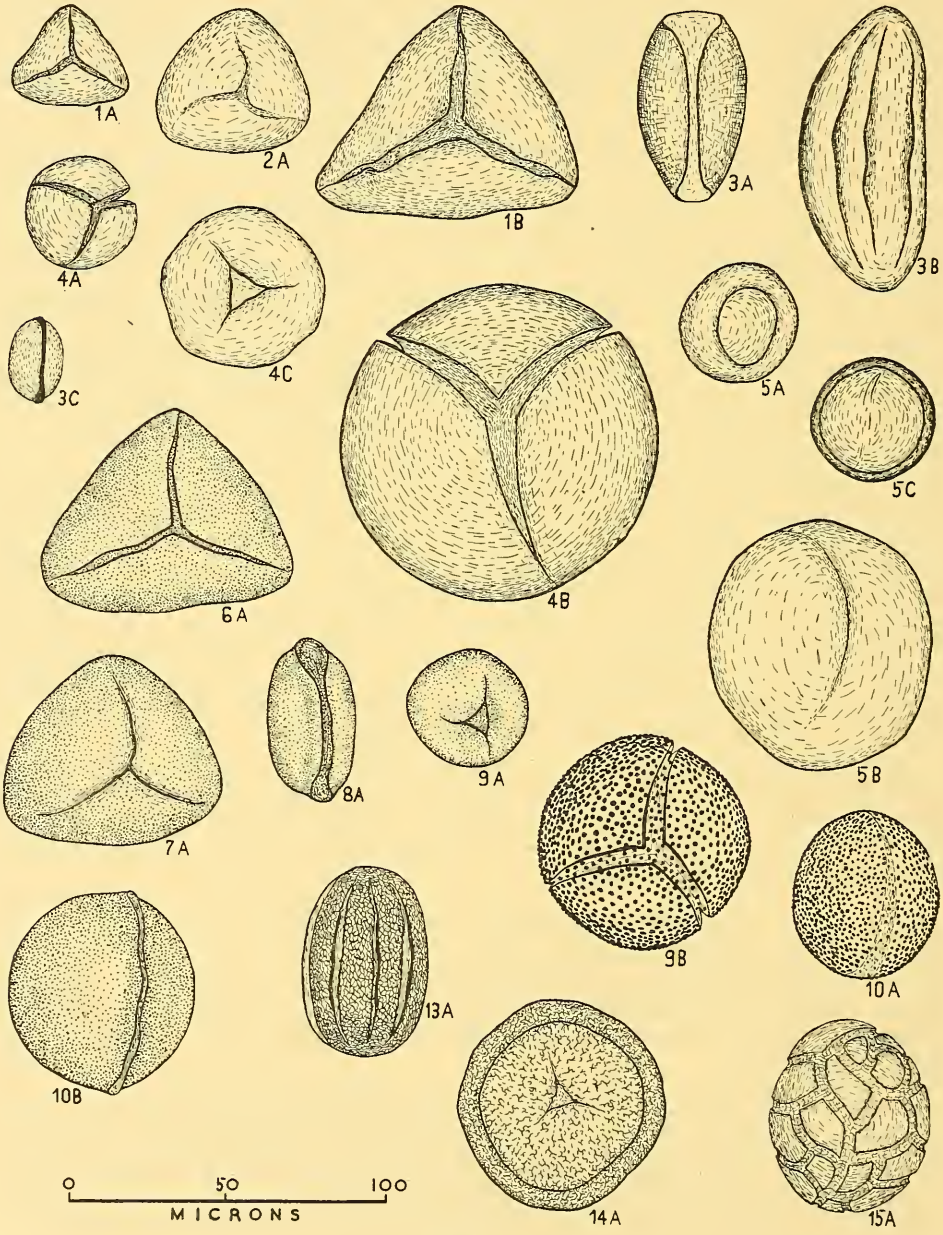

Fig. 1.

Type 3A. (Fig. 1. Plate vii, 3A.)

Ellipsoidal. Monolete dehiscence along a line running full length of body gives rise to longitudinal opening expanded towards extremities. Length 40–65μ; width in lateral view 24–36μ. Exine psilate.

Type 3B. (Fig. 1. Plate vii, 3B.)

Generally ellipsoidal; elongated curved body; curved, oval outline. Appears to be monolete with closed suture on more convex side of curved body. Length 90–140μ;

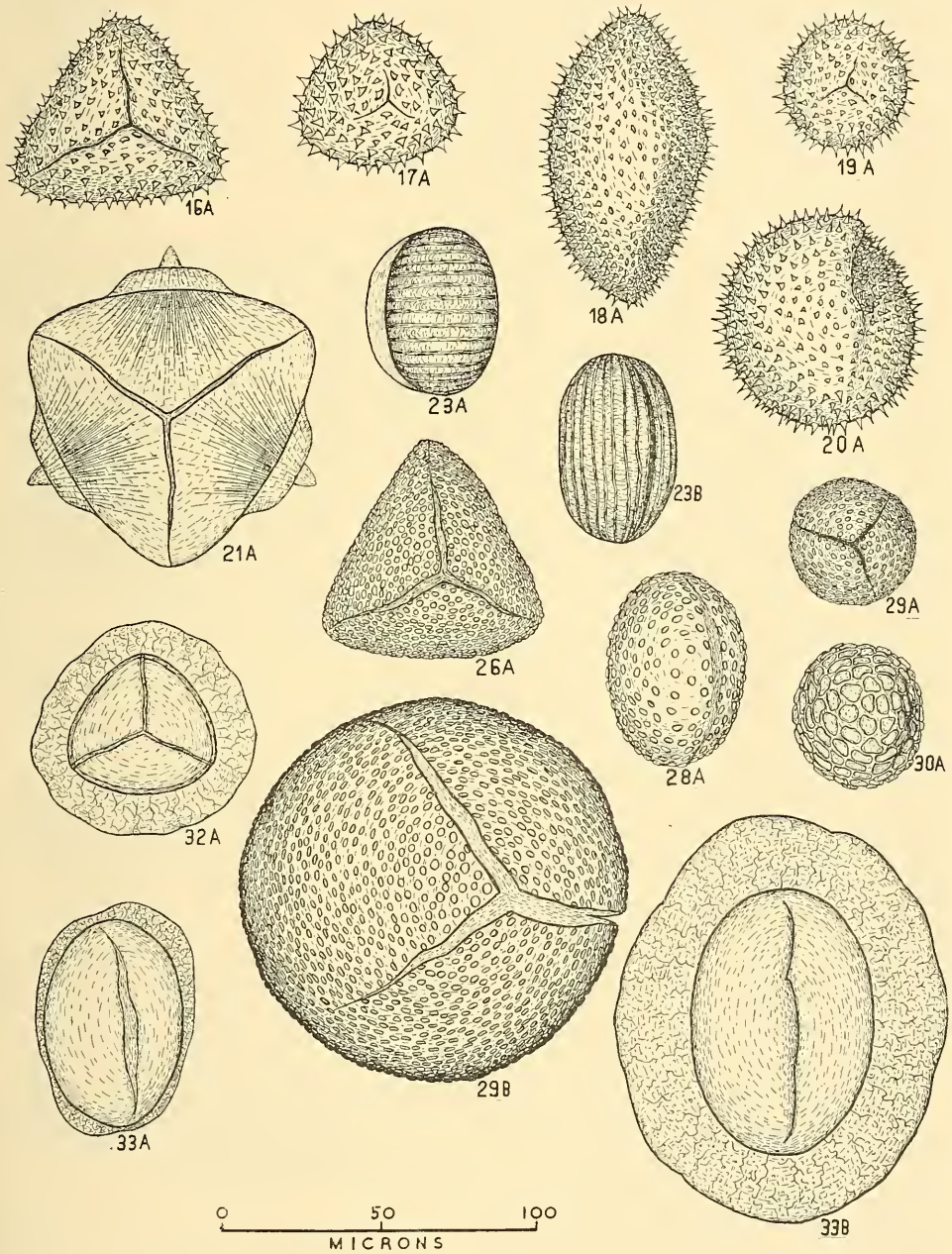

Fig. 2.

width 40–75μ. Exine generally psilate, although several longitudinal wrinkles or folds appear on the walls.

Type 3C. (Fig. 1. Plate vii, 3C.)

Ellipsoidal. Monolete; longitudinal suture, at times opened with lips turned outwards, runs full length of body. Length 20–30μ; width 12–17μ. Exine psilate.

Type 4A. (Fig. 1. Plate vii, 4A.)

Spheroidal; somewhat flattened proximal and distal sides; circular to slightly oval outline. Trilete with frequently opened sutures extending from centre to margin in full proximal view. Diameter 20–40μ. Exine psilate.

Type 4B. (Fig. 1. Plate vii, 4B.)

Flattened spheroidal shape generally similar to Type 4A, but much larger and more variable in size; diameter 75–135μ. Trilete with well-developed triradiate sutures extending to, or beyond, margin in proximal view. Dehiscence common along sutures, in some instances tending to trisect the spore case.

Type 4C. (Fig. 1. Plate vii, 4C.)

Spheroidal with much flattened proximal and distal sides. Circular outline in axial view. Trilete; triradiate sutures extend short distances from their origin, but give rise to small, well-defined triangular opening at centre. Diameter 40–80μ. Exine psilate.

Type 5A. (Fig. 1. Plate vii, 5A.)

Spheroidal with slight distal and proximal flattening giving circular or slightly oval outline. Monolete dehiscence gives rise to large oval opening on proximal side. Normally small but varies considerably; diameter 16–40μ. Exine psilate.

Type 5B. (Fig. 1. Plate vii, 5B.)

Spheroidal to suboblate with circular or slightly oval outline. Monolete with ill-defined suture or elongated area appearing straight, or curved, depending on position, but seldom exhibiting distinct opening. Size variable, 45–120μ. Walls appear relatively thin. Exine psilate.

Type 5C. (Fig. 1. Plate vii, 5C.)

Spheroidal; distinctly flattened and circular outline in axial view. Appears to be monolete, although regular sutures or distinct openings have not been observed. Usually very small with diameter of 17–20μ, but varies from 14–40μ. Exine psilate and very thick-walled giving a dark rim round the body.

Type 6A. (Fig. 1. Plate vii, 6A.)

Angular tetrahedral; well-defined apices; flat or slightly convex sides; triangular outline. Trilete with long, frequently opened sutures extending to distal apices. Size variable, 40–100μ from apices of the tetrahedron to opposite sides. Exine granulate, normally of fine granular texture, but somewhat variable.

Type 7A. (Fig. 1. Plate vii, 7A.)

Subangular tetrahedral; rounded apices; convex sides; ill-defined triangular outline. Trilete; curved triradiate sutures seldom reaching distal apices. Size variable, 50–110μ from apices of tetrahedron to opposite sides. Exine granulate, normally of fine granular texture, but somewhat variable.

Type 8A. (Fig. 1. Plate vii, 8A.)

Ellipsoidal. Monolete; dehiscence extending full length of body produces longitudinal marginal opening usually expanded towards its extremities. Length 40–50μ; width in lateral view 23–28μ. Exine granulate of medium-fine granular texture.

Type 9A. (Fig. 1. Plate vii, 9A.)

Generally spheroidal; somewhat flattened; circular to slightly oval outline. A large depressed triangular area on one side of the body indicates a tetrad scar of trilete character. Diameter 24–38μ. Exine granulate of coarse granular texture.

Type 9B. (Fig. 1. Plate vii, 9B.)

Spheroidal; slightly to distinctly flattened; circular outline. Trilete with well-developed triradiate slits, which frequently tend to trisect the spore. Size variable; diameter from 50–100μ. Exine granulate varying from fine to medium-coarse granular texture.

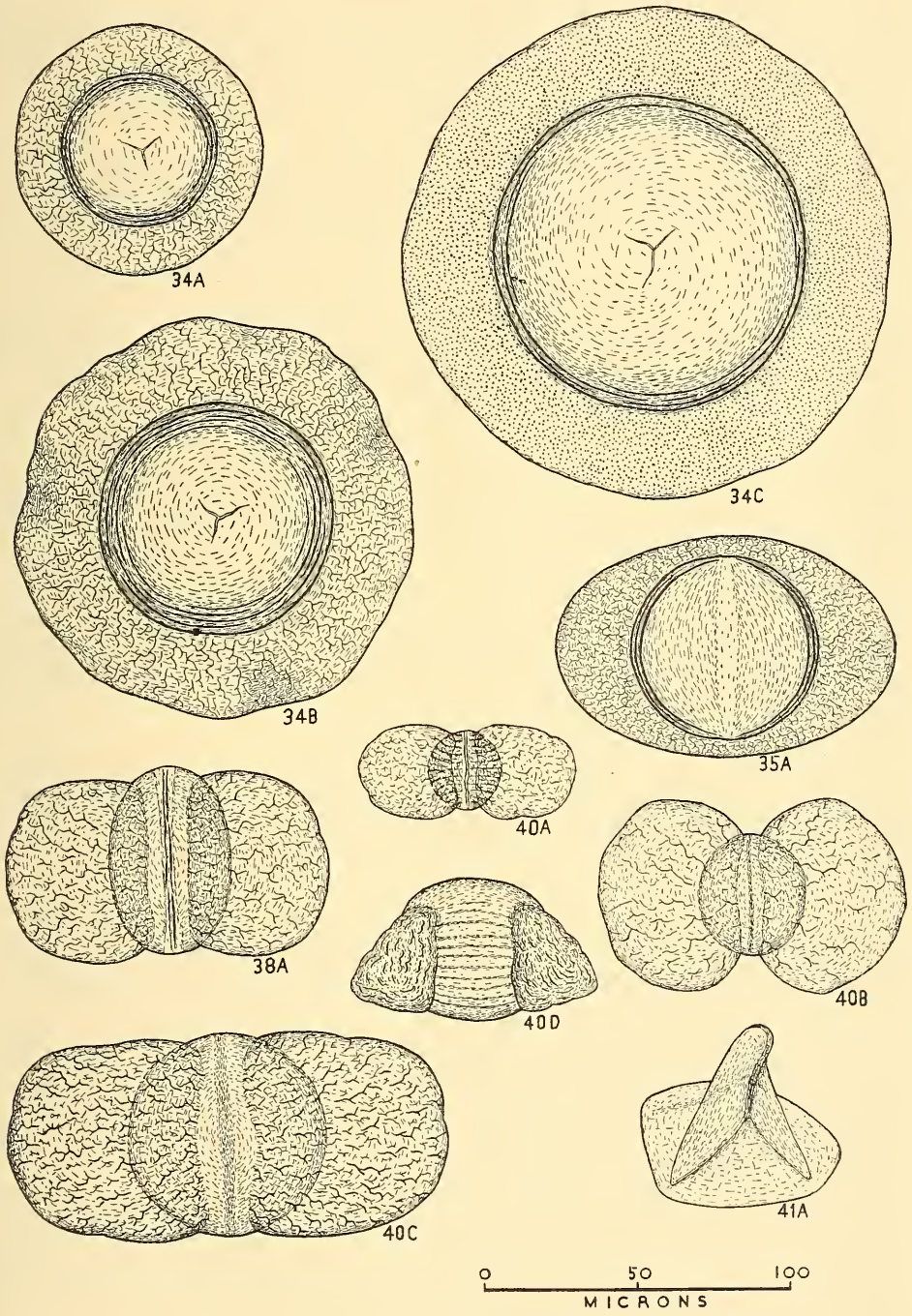

Fig. 3.

Type 10A. (Fig. 1. Plate vii, 10A.)

Spheroidal to suboblate; somewhat flattened; circular to suboval outline. Monolete tetrad scar up to 5μ in width at centre. Diameter 40–60μ. Exine granulate of medium-fine granular texture.

Type 10B. (Fig. 1. Plate vii, 10B.)

Spheroidal to suboblate; slightly flattened; circular to suboval outline. Monolete; well-developed slit extending the full width of the spore, in lateral view is usually open and expanded towards its extremities. Lips of the slit may protrude outwards. Diameter 50–80μ. Exine granulate of medium-fine granular texture.

Type 13A. (Fig. 1. Plate vii, 13A.)

Ellipsoidal with elongated oval outline. Monolete with indistinct suture situated marginally in lateral view. Length 50–70μ; width in lateral view 30–40μ. Exine usually exhibits several longitudinal folds or wrinkles, and a fine reticulum of anastomosing ridges between the folds.

Type 14A. (Fig. 1. Plate vii, 14A.)

Spheroidal; much flattened on proximal and distal sides; circular outline in axial view. Trilete with short triradiate slits normally opened to form a small triangular pit. Diameter 40–90μ. Exine reticulate with fine network of ridges. Ektexine thick, seen as dark band round the body in optical section.

Type 15A. (Fig. 1. Plate vii, 15A.)

Spheroidal to suboblate; slightly flattened; circular to suboval outline. Tentatively placed as monolete, although no definite slit or opening has been observed. Diameter 40–65μ. Exine reticulate, traversed by a widely-spaced system of large, anastomosing grooves about 4μ in width, and 10μ apart.

Type 16A. (Fig. 2. Plate vii, 16A.)

Tetrahedral; well-defined apices; flat to slightly convex sides; triangular outline. Trilete with slits extending to distal apices, and frequently opened. Size 40–70μ from apices to opposite bases of the tetrahedron. Exine echinate with small spines 3–4μ long, and 1–2μ wide at base, set 2–3μ apart.

Type 17A. (Fig. 2. Plate vii, 17A.)

Subangular tetrahedral; rounded apices; convex sides; rounded triangular outline. Trilete with short, ill-defined sutures extending towards distal apices. Diameter about 30–60μ. Exine echinate with large widely spaced spines of regular size pattern. Spines up to 7μ in length, and 3μ in width at base, set about 5μ apart.

Type 18A. (Fig. 2. Plate vii, 18A.)

Generally ellipsoidal. Definite evidence of tetrad scar or dehiscence lacking; but a longitudinal collapsed area suggests monolete character. Length 90–110μ; width 45–55μ. Exine echinate, spines up to 7μ in length and 3μ in width at base, set about 3μ apart.

Type 19A. (Fig. 2. Plate vii, 19A.)

Spherical or slightly oblate with circular or slightly oval outline. Trilete with short ill-defined sutures, rarely open. Diameter 28–40μ. Exine echinate with spines of constant size pattern on each individual, but varying on different individuals from 3 to 6μ in length, and 1·5 to 2·5μ in width at base, typically spaced about 6μ apart.

Type 20A. (Fig. 2. Plate vii, 20A.)

Spheroidal, but usually collapsed on one side, giving an outline which is completely circular or semi-circular with one side flattened depending on position. Nature of dehiscence or tetrad scar uncertain; but collapsed area on one side suggests monolete character. Diameter of sphere 60–80μ. Exine echinate with spines up to 6μ in length and 3μ in width at base, set about 3μ apart.

Type 21A. (Fig. 2. Plate vii, 21A.)

Tetrahedral; well-defined apices; slightly convex sides; generally triangular outline. Trilete with straight, well-defined triradiate sutures extending to distal apices. Size, 90–110μ from apices to opposite sides of tetrahedron. Situated at the centres of the three distal interfaces are three dome-shaped protuberances, each about 25μ wide at its base, projecting about 12μ beyond the margin of the body. In some cases a small cone-shaped projection, about 8μ at base and 7μ long, is present at the top of each dome. The exine of the three proximal faces is marked by coarse striae radiating from the base of each dome towards the triradiate sutures. The sutures are normally closed; but in some individuals they have been seen open to a width of 20μ, indicating definite dehiscence.

Type 23A. (Fig. 2. Plate vii, 23A.)

Ellipsoidal. Monolete suture extending full length of body along lateral margin; normally closed. A narrow frill-like fringe of smooth exine, 10–13μ wide, is associated with the suture, and projects beyond outline of body in lateral view. Length 50–60μ; width 40–50μ in lateral view. Exine ornamented with transverse striae about 3μ apart extending full width of body.

Type 23B. (Fig. 2. Plate vii, 23B.)

Ellipsoidal. Monolete with straight lateral suture, usually closed, extending full length of body. Length 55–65μ; width 40–45μ. Exine ornamented with longitudinal striae about 3·5μ wide extending full length of body.

Type 26A. (Fig. 2. Plate vii, 26A.)

Angular tetrahedral; apices well-defined; sides flat or slightly convex; triangular outline. Trilete with triradiate sutures extending to distal apices. Size 64–73μ from apices of tetrahedron to opposite sides. Exine verrucate with small, closely-packed, rounded elevations about 2·5μ in diameter and 1μ apart.

Type 28A. (Fig. 2. Plate vii, 28A.)

Ellipsoidal; ellipse of low eccentricity; suboval outline. Monolete with well-defined suture running full length of body. Length 50–70μ; width 40–50μ in lateral view. Exine verrucate with small, widely-spaced, rounded elevations about 2μ in diameter, and 4–5μ apart.

Type 29A. (Fig. 2. Plate vii, 29A.)

Approximately spheroidal; slightly flattened; rounded to slightly oval outline. Diameter 35–50μ. Trilete with well-marked triradiate sutures extending to margin in full proximal optical section. Exine verrucate with rounded elevations about 2μ in diameter and 3μ apart.

Type 29B. (Fig. 2. Plate vii, 29B.)

Spheroidal; slightly flattened; circular outline. Trilete with well-developed triradiate sutures, frequently opened, extending to margin in full proximal optical section. Diameter 130–170μ. Exine verrucate with large rounded elevations 4–5μ in diameter, and 2–3μ apart.

Type 30A. (Fig. 2. Plate vii, 30A.)

Spheroidal to suboblate; slightly flattened; circular to suboval outline. Monolete with short, ill-defined suture, at times accompanied by a small collapsed area. Diameter 35–50μ. Exine verrucate with large, rounded elevations 6–7μ in diameter, and 2–3μ apart.

Type 32A. (Fig. 2. Plate vii, 32A.)

Monowinged with subangular, tetrahedral body exhibiting rounded apices; convex sides; rounded triangular outline. Trilete with well-defined triradiate sutures seen as double lines along proximal interfaces. Body psilate, 50–80μ from apices of tetrahedron to opposite sides. Wing marked with radiating venation, and situated in one plane

round body and attached to distal interfaces of the tetrahedron, has an approximately circular outline and crenulate margin; wing 15–20μ wide.

Type 33A. (Fig. 2. Plate vii, 33A.)

Monowinged with ellipsoidal body. Monolete; single longitudinal suture about 5μ wide extending almost full length of body. Body psilate, 60–80μ long, and 40–60μ wide. Single narrow wing with oval outline, and with faint reticulate marking varying in width from 3μ to 10μ in one individual, situated in lateral plane round body.

Type 33B. (Fig. 2. Plate vii, 33B.)

Monowinged with ellipsoidal body. Monolete; single longitudinal suture, 5–7μ wide, extending almost full length of body. Body psilate, 80–110μ long, and 40–60μ wide. Single wing, 28–40μ wide with oval outline, situated in lateral plane round body; faintly reticulate, and somewhat granular appearance.

Type 34A. (Fig. 3. Plate vii, 34A.)

Monowinged with flattened spheroidal body. Trilete character indicated by short, indistinct triradiate sutures seen only in well-preserved examples. Body psilate, 50–80μ in diameter. Single circular wing, 12–18μ wide, continuous in one plane round body, and marked with radiating reticulum. Several concentric lines appear at junction between wing and body.

Type 34B. (Fig. 3. Plate vii, 34B.)

Monowinged with flattened spheroidal body. Trilete characters similar to Type 34A. Body psilate, 90–120μ in diameter. Single circular wing, 20–40μ wide, continuous in one plane round body, and marked with radiating reticulum. Several concentric lines occupy relatively wide zone at junction between wing and body.

Type 34C. (Fig. 3. Plate vii, 34C.)

Monowinged with spheroidal body. Trilete characters similar to Types 34A and 34B. Body psilate, 100–130μ in diameter. Single circular wing, 25–35μ wide, continuous in one plane round body, and ornamented by fine granular marking. Several concentric lines appear at junction between wing and body.

Type 35A. (Fig. 3. Plate vii, 35A.)

Monowinged with flattened spheroidal body. Monolete character indicated by indistinct, narrow germinal area extending across body. Body psilate, 50–80μ in diameter. Single wing with oval outline and reticulate venation, continuous in one plane round body, and situated with short axis of elliptical outline in direction of germinal area. Width of wing 9–12μ in direction of germinal area, and 20–30μ in opposite direction. Narrow zone at junction between body and wing, widest in direction normal to that of germinal area.

Type 38A. (Fig. 3. Plate vii, 38A.)

Biwinged with ellipsoidal body. Monolete, exhibiting narrow, longitudinal germinal area extending full length of body. Body psilate, 40–80μ long, and 30–60μ wide. Two wings, marked with radiating venation and normally equal to or slightly larger than the body but of variable shape and size, are situated symmetrically on either side of the germinal area towards which zones of attachment extend.

Type 40A. (Fig. 3. Plate vii, 40A.)

Biwinged with slightly flattened spheroidal body. Monolete, exhibiting narrow germinal area extending across body between roots of wings. Body, 25–40μ in diameter, frequently exhibits coarse striae transverse to germinal area. Two relatively small, somewhat elongated wings marked with radiating venation, and normally slightly wider and considerably longer than diameter of body, but of variable shape and size, are situated symmetrically on either side of germinal area towards which zones of attachment extend.

Type 40B. (Fig. 3. Plate vii, 40B.)

Biwinged with slightly flattened spheroidal body. Monolete, exhibiting narrow germinal area extending across body between roots of wings. Body psilate, 35–50μ in diameter. Two relatively large, rounded wings marked with reticulate venation, frequently twice width of body but of variable shape and size, are situated symmetrically on either side of the germinal area with large zones of attachment.

Type 40C. (Fig. 3. Plate vii, 40C.)

Biwinged with flattened spheroidal body. Monolete character similar to Type 40B. Body psilate, 50–80μ in diameter. Two wings with reticulate venation, normally rounded or slightly elongated and about same size as body but of variable size and shape, are situated symmetrically on either side of germinal area with large zones of attachment.

Type 40D. (Fig. 3. Plate vii, 40D.)

Biwinged with flattened spheroidal body. Germinal area not evident, but probably situated between roots of wings. Body 35–55μ in diameter, marked with coarse striae between wings. Two small lobe-like wings with wrinkled or folded surfaces, attached symmetrically to one side of the body, protrude only a limited distance beyond its margin, and are directed away from the proximal part of the spore.

Type 41A. (Fig. 3. Plate vii, 41A.)

This microspore has been tentatively classified in terms of Table 1, as its morphology is not yet clearly understood. The illustration in Fig. 3 is intended to show the appearance in optical section. The general features are typical, and the type has been recognized in coals from a number of different seams. The spore appears to consist of a flat disc-shaped portion (45–70μ in diameter), to one side of which is attached a large, elevated structure projecting considerably beyond the margin of the disc. The exine is psilate, and no opening or dehiscence has been observed.

Acknowledgements.

The author wishes to acknowledge the assistance of F. V. Mercer, B.Sc., Department of Botany, University of Sydney, in the interpretation of microspore structures, and valuable discussion with Dr. A. B. Walkom, Director, Australian Museum. The terminology adopted by Erdtman (1943) has been adhered to as closely as possible in describing the spore-types.

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EXPLANATION OF PLATE VII.

Photomicrographs of some of the principal microspore-types occurring in the New South Wales Permian coals, × 400.